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MANITOBA PLANT DISEASE CONTROL GUIDE FOR CEREALS, POTATOES, SPECIAL CROPS AND VEGETABLES

Prepared by: Manitoba Agriculture
Soils and Crops Branch
Plant Pathology Laboratory

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PRINCIPLES OF DISEASE CONTROL

Disease losses are serious every year in Manitoba. They result from reduced yield, grade or marketability that occurs at planting, growing, harvesting or storing. An average of 5% loss occurs annually in cereal crops and special crops. In some years when disease incidence is high, disease loss can be up to 100% in individual fields.

A disease can be defined as any process that interferes with the normal growth of a plant. Disease can be very destructive resulting in death of the plant such as in severe root rot or may result in only slight damage such as an occasional spot.

Plant diseases can be divided into two broad categories:

A) Non - infectious disease caused by:
   1. nutrient deficiencies
   2. extremes of temperature, hot or cold
   3. excess or deficiency of water

B) Infectious diseases caused by:
   1. microscopic organisms such as fungi, bacteria, viruses and nematodes
   2. less common causes are mycoplasma like organisms (MLO), slime moulds, and parasitic plants

Most micro-organisms are beneficial for natural decay. Only relatively few cause plant diseases. The principal disease causing organisms in Manitoba are fungi. Stem and leaf rust, and smut diseases of cereals, root rot of cereals and special crops, sclerotinia disease of canola and sunflowers are examples of serious diseases caused by fungi. Bacteria and viruses cause only a few diseases of crops. Ring rot of potatoes is a very important disease caused by a bacterium. Barley yellow dwarf disease of wheat, barley and oats and mosaic of numerous ornamentals are examples of diseases caused by virus. Flame chlorosis, an important new disease of barley, is suspected to be caused by a virus but not definitely confirmed. Nematodes have not been troublesome in Manitoba except on a few such as sugar beets and greenhouse crops.

The only disease of any consequence in Manitoba suspected to be caused by a mycoplasma like organism (MLO) is aster yellows of barley, wheat, canola, buckwheat, flax, lettuce, carrots and celery. Serious yield losses seldom occur in the cereal and special crop hosts but aster yellows can be very destructive to vegetable crops.

Parasitic plants seldom cause diseases in crops but can cause severe damage to forest trees (eg.) dwarf mistletoe of Jackpine and spruce. Dodder is a parasitic plant which is occasionally found attacking flax.

Slime moulds are very rarely encountered as a cause of plant disease (eg.) slime mould of strawberries.

DISEASE DEVELOPMENT

Infectious disease results when susceptible plants are invaded by a disease causing organism. The severity of plant disease is directly influenced by weather. The relationship is usually complex involving moisture, temperature wind and light. Infectious disease organisms such as rust or smut spores are spread by winds. Bacteria are commonly spread by splashing rain. Viruses and MLO are often spread by insects such as aphids and leaf hoppers.

In order for a disease to develop conditions must be suitable for infection and subsequent development of the disease. Most fungi and bacteria require free water on the plant surface for spore germination and subsequent infection, which can come from dew, rain or fog. Cloudy, foggy weather with moderate temperatures favors many leaf diseases. Root rot develops most readily under extremes of wet or dry soils. In both cases plant growth is under stress and the plant is more vulnerable to attack of the disease causing organisms. Plants under nutrient stress are often more susceptible to disease. Some diseases can be partially controlled by applications of fertilizer (eg) browning root rot of wheat is reduced by an application of phosphate and take all root rot of wheat by Potassium chloride applications. Excess nutrient supply especially of nitrogen can increase the incidence of some plant diseases by creating a more dense plant canopy (eg.) stem rot of canola.

DISEASE CONTROL

Disease control occurs when the life cycle of the pathogen is halted. This occurs when the environment becomes unfavorable for the organism to grow or the plant host is not available for the pathogen to attack.

Disease control can be categorized into several areas. These are:

A) Avoid the disease organism
   1. Select a planting site or field not contaminated by the disease causing organism
   2. Use varieties that are resistant to the disease
   3. Bury infected crop residue after harvest
   4. Practice crop rotation
   5. Plant early
   6. Harvest at proper time and store crop under ideal storage conditions

B) Exclude the disease organism

Certified seed of a number of crops is inspected for disease and when the amount of disease exceeds tolerance limits the field of seed is not certified. (eg) ring rot of potatoes has a 0

tolerance.
Quarantine laws prevent disease spread from country to country or province to province.

C) Eradicate the disease causing organism or its vector
1. Remove diseased plants from fields by roguing (eg) potato fields are rogued for virus infected plants
2. Separate diseased plant part, or parts of the disease organism from seeds (eg) ergot can be cleaned out of rye seed by a specific gravity seed cleaner
3. Soil fumigation eliminates disease causing fungi, bacteria and nematodes
4. Insecticides are used to stop an invasion of vectors (aphids, leaf hoppers) that carry viruses and mycoplasmas

D) Protect the crop plant from disease

Chemical protection through the use of fungicide and bactericides, kill disease causing fungi on seeds such as smut or blight and provide some protection from soil borne fungi that cause seedling decay and blight. Leaves and stems are sprayed to prevent infection by fungi and bacteria causing diseases such as white mold, early blight, bacterial blight and leaf spot.

There are only a few diseases of special crops where fungicides (other than seed treatment) are recommended.

Sclerotinia disease of field beans and canola (rapeseed can be controlled by an application of benomyl (Benlate), iprodione (Rovral) at flowering time. Mancozeb (Dithane M45) is registered for control of leaf rust, tan spot and Septoria of wheat. Propiconazole (Tilt) is registered for control of leaf diseases of semi-dwarf and soft white wheat and barley. Triadimefon (Bayleton) is registered for control of rust and powdery mildew of winter wheat.

There are many recommendations for fungicide applications on vegetables and potatoes. These recommendations are summarized in Table 3. (Fungicides Registered for Disease Control in Potatoes and Vegetables). Seed treatments for cereals and special crops are presented in Table 1.

E) Disease Control Through Crop Rotation

Crop rotation, alternating cereal crops with broad leaf special crops will reduce incidence of root rot. Many special crops are subject to the same diseases such as root rot and sclerotinia white mold and thus cannot be grown in the same crop rotation or must be spaced at least three years apart. These include: fababeans, field beans, field peas, lentils, mustard, canola, rapeseed, safflower, soybeans and sunflowers.

Table 2, gives an indication of the number of years that various crops should be spaced apart in a crop rotation for disease control. A crop rotation is also affected by herbicides that have a residual action. A detailed chart on crop rotation integrating disease,

herbicide, volunteer crop and fertility considerations has been prepared by the Manitoba Agronomists Committee and published by Manitoba Agriculture.

Vegetable crop disease control recommendations are included in the "Vegetable Crop Production Guide" available from Manitoba Agriculture publications.

The Strawberry and Raspberry Spray Calendars list disease control recommendations for strawberries and raspberries. Recommendations for control of turf and lawn grass diseases and greenhouse diseases are available from the Manitoba Agriculture Plant Pathology Laboratory

FUNGICIDE FORMULATIONS

Most fungicides are solids that are not soluble in water. In order to use them they must be made into a formulation (preparation). Some of the more common formulations are listed below. The common abbreviation for each formulation is given in parentheses following the name.

Wettable powder (WP). Many fungicide formulations are wettable powders. This is a powder consisting of solid fungicide and a wetting agent. When mixed with water it forms a suspension. Many of these suspensions settle out quickly, so an agitator is needed in the spray tank to keep the particles in suspension.

Dusts (DU). These are powders that are mixed with inert ingredients to form a product with a low percent of active material.

Granules (G). The active ingredient is incorporated into small granules of inert material (such as clay). A few fungicides such as Terraclor are formulated this way for application to the soil.

Solutions or soluble powders (Sn). These are products where the fungicides are soluble in water.

Liquid concentrates (LC). These are concentrated solutions (see above).

Flowables (Su). These are insoluble fungicides ground into a very fine product, usually by a wet grinding process. These particles are nearly colloidal in size and are suspended in water to form a thick liquid. They remain suspended in water for relatively long periods of time, but should be agitated before use. They are increasing in popularity over wettable powders because they are dust-free, easy to mix, remain in suspension longer, any may also resist washing off the plant better than the wettable powders.

Fumigants. These are liquids which turn into a gas after application. They are generally used for soil fumigation.

MODE OF ACTION OF FUNGICIDES

The action of most fungicides takes place outside the host, as discussed below. This is called "protection". A fungicide that acts outside the host is called a "protectant fungicide". Most fungicides sprayed on leaves and fruit are of this type. "Therapy" is chemical action inside the host - there are relatively few cases of this.

Most protectant fungicides are relatively stable by themselves. Generally they are relatively insoluble in water and resist removal or chemical change by water, yet must be toxic to fungi. Often a chemical change is brought about by the fungus, the host, or the environment before toxicity occurs. Toxicity simply means the ability to do damage to the fungus cells.

There are several different ways that fungicides may act to produce a toxic reaction. (1) Some may inhibit (slow down or stop) cell wall formation. This is true of the action of certain antibiotics on bacteria.

(2) The permeability of the cell wall may be affected,causing a leaking of nutrient materials from the cell.

(3) Some fungicides may combine with essential metals in a way that they become unavailable for normal cell functions, including the functioning of essential enzymes.

(4) Other fungicides may inhibit respiration, nuclear division, or may break dormancy of spores.

Some fungicides may also be toxic to plants. This is called phytotoxicity. For example, folpet (Phaltan), is chemically related to captan, is a more active fungicide, but its use is limited because it is more phytotoxic. Formulations of maneb and zinc are less phytotoxic to many vegetables than formulations that contain only maneb. Sometimes the method of formulation may make a fungicide less phytotoxic.

APPLICATION OF FUNGICIDES

The various methods of applying fungicides include seed treatment, spraying, dusting, soil treatment, dipping, drenching and soil injection. The most common methods of application used in Manitoba are seed treatment and spraying.

DISEASE CONTROL

In control of smuts, seed of resistant varieties, and seed of susceptible varieties free of smut should not require treatment. No yield benefit results from treating sound seed of a resistant variety with a seed treatment. When smut is observed in a crop being used for seed, it should be treated. If a producer uses his own seed of a susceptible variety and there is doubt as to infection by smut or bunt, seed treatment is a wide precaution. The recommended interval between treatments is given for the various crops under Disease

Control. Agriculture Canada Publication 1766/E 1984 "Smut diseases of wheat, barley, oats and rye", will aid in recognition of smut in the field.

Use a suitable chemical with a Pest Control Products Act number (PCP No.). Recommended chemicals are shown in Table 1. Seed treatment chemicals are poisonous so guard against inhaling dust or fumes, and wear a mask where recommended in the product label. Wash with soap and water periodically to remove chemical lodging on hands and face while treating.

Thorough, clean equipment used in mixing treated grain before it is used for untreated grain. Empty containers of chemicals should be disposed of at an authorized pesticide container disposal site.

CAUTION: Treated grain must not be mixed with untreated grain for feed or sale. Treated leftover seed may be saved for planting the following year; otherwise it should be buried at a depth and location where it will not be accessible to animals or contaminate water supplies. Leftover treated seed from a previous year should be checked for germination percentage prior to planting as some seed treatments may reduce seed viability.

Seed Treatment can have three purposes, although all three are seldom met in average cases. One of the major reasons for treating seed is to inhibit the growth of pathogens borne on the surface of the seed. Covered smut of barley, false-loose smut of barley, loose and covered smuts of oats, and bunt of wheat, are pathogens borne on the seed surface. Seed treatment can inhibit the growth of these pathogens, greatly reducing the amount of infection of young seedlings. Seed treatment is the major means of control of all of the seed-borne diseases listed above.

A second reason for treating seed is to protect the seed against soil-borne pathogens. This is especially important when conditions are unfavorable for the rapid germination and emergence of seed: the longer the seed is in the ground, the greater the danger of seed rotting or seedling damping-off. Damping-off is a rapid death of young seedlings. Seed treatment is also very important for protecting damaged seed against soil-borne pathogens. Flax seeds with damaged seed coats are much more liable to attack and destruction by soil-borne pathogens than are sound seeds.

A third reason for treating seed is to destroy internally seed-borne pathogens such as the loose smuts of barley and wheat. These are internal infections and the protectant fungicides used to protect against surface borne pathogens and soil-borne pathogens are ineffective against these pathogens. The systemic fungicide, carbathiin (Vitavax), is capable of entering the growing seedling, moving systemically through it and preventing further development of the loose smut fungus, which is systemic in the plant.

Seed may be treated by commercial seedsmen or it may be treated on the farm. Commercial seed treatment may use a slurry treater, or various automatic seed treaters. The various automatic seed treaters

differ considerably and so cannot be discussed here. Commercial seedsmen using flowable fungicides should be sure to clean off the chemical metering cups every day to prevent a buildup of fungicide which causes low delivery rates.

On-farm treatment may use various home type or slurry mixers, but drill box seed treatment is popular because no extra steps are required since the seed is treated in the drill-box at planting time. This eliminates the need for special seed treating equipment and avoids the problem or left over seed that cannot be used. Caution is needed in the proper use of drill box seed treatment. Good disease control depends on even and uniform fungicide coverage of the seed. This is more difficult to accomplish in drill box treatment because of inadequate means of mixing the seed and fungicide For effective drill box treatment, fill the box with one third the quantity of seed and fungicide and mix carefully with paddle, repeat with the next third, and then the final third. The paddle should not be used for any other purpose and should be stored in a safe place where children and animals cannot get to it.

The most common and satisfactory on farm seed treatment meters fungicide into the base of the auger used to fill the drill box. This assures good mixing and coverage. If a powder is used, dust may be an irritating problem; adequate protective clothing and a chemical respirator should be used. If a liquid is used, there will be no dust problem.

There are certain basic precautions in all seed treatment. Care should be used in handling seed treatment products - if not highly poisonous many are at least irritating to the eyes and nose. Treated seed is usually identified by the dye used in the chemical, and treated seed should not be fed to livestock or used for human food. Pesticide containers should be properly disposed of in a land fill or buried in an area where there is no surface drainage to nearby water ways If seed treatment cannot be done outdoors it should be done in a well ventilated room. Commercial seed treaters should have an adequate air exhaust system for treatment rooms. Workers exposed to seed treatment chemicals for long periods of time should have an approved chemical mask. The filter should be changed frequently. Recommended rates of application should be carefully followed as higher rates may injure the seed and lower rates may not give satisfactory disease control.

Spraying: This can be done with many different types of ground and air, equipment. The important thing is to get good coverage; 22 L./acre is usually used for aerial application and higher volumes for ground equipment.

Droplet size for aerial application should be 200-400 microns (1/64 - 1/128") in diameter. Generally, if nozzles are pointed back, appropriate nozzles used, and pressures do not exceed 200-240 KPa (30-35 psi), the correct droplet size will result. Application should be made with the boom 1.90 - 2.5 M (6-8 ft) above the crop.

Some plants have a waxy or hairy coating on them, making good

coverage difficult. Frequently the spray will collect in large erect droplets which then run off. Wheat and canola leaves are good examples. Frequently it is necessary to use a wetting agent with wettable powders. Usually this is a spreader-sticker. Certain fungicides may work better with certain spreader-stickers than others. This type of information can usually be found on the label or else in supplemental brochures. Spreader-stickers are usually incorporated in flowable formulations, so that it is not necessary to add a spreader-sticker to the spray tank.

SCLEROTINIA DISEASE Sclerotinia sclerotiorum can cause serious diseases in a great variety of broadleaved special crops including fababeans, field beans, field peas, lentils, mustard, canola, rapeseed, safflower, soybeans and sunflowers. Vegetable crops such as carrots, green beans, and garden peas, along with many weeds such as thistles, wild mustard, ragweed and burdock are hosts.

The pathogen overwinters in Manitoba soils by means of black, hard bodies or sclerotia, variable in shape (round, flat, short, elongated) and size measuring from a few millimeters to several centimeters. Infection is caused by two ways:

-- by direct mycelial germination
-- by air borne ascospores produced by inconspicuous, tiny mushrooms or apothecia

Direct germination causes root infection and occurs primarily in sunflowers. This infection results in root rot and basal stem rot, noticeable by a wet lesion at the stem base and a sudden wilting of the plant. Infection by ascospores causes head and stalk rot in sunflowers, and white mold or stem rot in other crops. Spore infection occurs under conditions of continuous heavy rainfall.

Airborne infections are further enhanced by the presence of senescent (old or dead) tissue such as florets of sunflower heads and flower petals of other crops that drop and become lodged in leaf axils. Senescent tissue is needed - by the germinating spore as a food base, in order for the infection to be successful.

Sclerotinia diseases are partially controlled by at least a four year rotation between host crops, as well as use of sclerotia-free seed and weed control. Airborne infections are further reduced by seeding to allow maximum air circulation and fast drying, and by timely spraying with recommended chemicals on approved crops. With sunflowers, damage from Sclerotinia wilt is reduced by using minimum populations planted at maximum distances.

CROP ROTATION Alternating of broadleaf and cereal crops is generally recommended. Further information on crop rotation can be obtained from the bulletin "Crop Rotation Chart".

A table detailing some common diseases of field crops and special crops in Manitoba follows (Table 2). It shows which occur on more than one crop and the longevity of these diseases in field in the

Pesticides

Pesticide Safety Symbols

All pesticide container labels carry safety symbols indicating the degree of hazard and risk to the user.

The **categories of risk** are indicated by the following symbols:

Danger

Warning

Caution

Products that are the most toxic and pose the highest risk to the user carry the **DANGER** symbol. **WARNING** and **CAUTION** are less dangerous, respectively. Where the risk is minimal, no symbol is required on the container label.

The **categories of hazard** are represented by the following symbols:

Poison

Corrosive

Flammable

Explosive

Categories of Risk symbols are used in conjunction with **Category of Hazard** symbols on product labels. For example, the following symbol would mean danger — explosive.

Because most pesticides are poisons, the remainder of this page explains the toxicity of the poison risk symbols and lists the type of safety equipment that should be worn by the user.

Poison Risk Symbols

Danger—Poison

***LD50** (see end of page for explanation):

- oral, less than 500 mg/kg
- dermal, less than 1000 mg/kg

Probable Lethal Dose for 68 kg (150 lb.) person:

- 7 drops to 28 mL (1 oz.) swallowed
- 7 drops to 85 mL (3 oz.) absorbed

Safety Clothing To Be Worn:
Respirator, goggles, clean coveralls, water repellent hat, rubber gloves, rubber boots.

Warning—Poison

***LD50** (see below):

- oral, 500 – 1000 mg/kg
- dermal, 1000 – 2000 mg/kg

Probable Lethal Dose for 68 kg (150 lb) person:

- 28 to 85 mL (1 to 3 oz.) swallowed
- 85 to 200 mL (3 to 7 oz.) absorbed

Safety Clothing To Be Worn:
Goggles, clean coveralls, water repellent hat, rubber boots, rubber gloves.

Caution—Poison

***LD50** (see below):

- oral, 1000 – 2500 mg/kg
- dermal, 2000 – 5000 mg/kg

Probable Lethal Dose for 68 kg (150 lb.) person:

- 85 to 227 mL (3 to 8 oz.) swallowed
- 200 to 455 mL (7 to 16 oz.) absorbed

Safety Equipment To Be Worn:
Clean coveralls, water repellent hat, rubber boots, rubber gloves.

***LD50** — *a measure of toxicity that indicates the amount of pure pesticide that would produce a 50% mortality in a test animal population (rats, mice, guinea pigs).*

Source: Pesticides Division, Agriculture Canada.

FUNGICIDES

BENLATE (BENOMYL)

BRAVO (CHLOROTHALONIL)

CAPTAN (CAPTAN)

DEXON (FENAMINOSULF)

DITHANE M-22 (MANEB)

DITHANE M-45 (MANCOZEB)

DYRENE (ANILAZINE)

EASOUT (THIOPHANATE METHYL)

FIXED COPPER 50W (FIXED COPPER)

KOCIDE (FIXED COPPER)

LESAN (FENAMINOSULF)

MANZATE D(MANEB)

MANZATE 200 (MANCOZEB)

MERTECT (THIABENDAZOLE)

POLYRAM (METIRAM)

PRO - GRO (CARBATHIIN-THIRAM)

ROVRAL (IPRODIONE)

THIRAM (THIRAM)

VITAVAX 280 (CARBATHIIN)

Eye Protection

The use of protective goggles is necessary and recommended when a full face mask is not worn.

Many goggles are chemical resistant. Some have specially treated lenses to reduce fogging. Others have anti-fogging ventilation. Prescription type safety spectacles are also available. Side shields can be attached when necessary.

Gloves

Non-absorbent gloves should be worn at all times while handling, mixing and applying pesticides. Neoprene has been found superior to rubber in resisting the absorptive penetration of many substances associated with pesticides.

Other factors to be considered in selecting suitable gloves include sense of touch, wet grip, cut resistance, and abrasion resistance. Gloves should fit snugly. Fabric wrist gloves should not be considered.

Footwear

Non-absorbent footwear should be worn when applying pesticides. The most suitable boot is one that is knee length, acid and solvent resistant, and cleated or ribbed to prevent slippage. Neoprene is considered superior to rubber in withstanding various acids and solvents.

Other Clothing

A major concern in agricultural pesticide spraying is the unwillingness of the applicator to wear some form of protective clothing, particularly under warm summer conditions. At the very least, coveralls should be worn along with gloves and a hat to minimize the hazard of dermally toxic (absorbed through skin) pesticides. The clothing should be changed and washed following spraying.

Disposable garments suitable for pesticide work are now available. Made of "Tyvek" polyethylene fibres, such clothing will provide protection against dermal exposure resulting from pesticide drift, splashing, or spills. Lightweight and economical, disposable garments are available as coveralls, shirts, pants, headcovers, and aprons.

Supplies of goggles, prescription type safety spectacles, neoprene gloves, boots and other protective clothing including hats are available from any one of the major safety supply companies listed below.

Availability

Many pesticide dealers stock personal protective equipment for pesticide users. In addition, several Manitoba safety supply companies provide a wide range of products. Some firms offer complete lines, others specialize. The following companies can meet the needs of pesticide users:

- IPACO Safety Products — 775-8208 (Wpg.)
- Levitt - Safety Limited — 633-7228 (Wpg.)
- MSA Canada Incorporated — 632-7570 (Wpg.)
- McVicar Safety Supplies Limited — 889-3787 (Wpg.)
- Safety Centre Limited — 772-2495 (Wpg.)
- Safety Supply Canada — 453-7838 (Wpg.)

Check the telephone directory Yellow Pages for addresses and branch locations.

In case of accident or poisoning with any pesticide, contact your local hospital. For further information, contact:

Poison Control
Health Sciences Centre
Children's Centre
685 Bannatyne Avenue
Winnipeg, Manitoba, R3E 0W1
Telephone: 1-787-2591

General Pesticide Recommendations

For proper pesticide use:

- identify the pest problem.
- use the recommended pesticide.
- apply according to directions.

General Pesticide Guidelines

Know and observe the following guidelines:

- Never smoke while applying pesticides.
- Avoid inhaling sprays or dusts. Wear protective clothing and a respirator. Additional detail on personal protective equipment is provided below.
- Sprayer lines carrying pesticides must not enter the operator's cab.
- Have soap, water and a towel available. Should concentrated product spill on skin, hands, face or eyes, wash immediately.
- Wash hands and face when leaving the treated area — before break periods, lunch, or for comfort.
- Bathe or shower and change to clean clothing after working with pesticides. Wash clothing each day before re-use.
- Call a physician or get the patient to a hospital immediately if symptoms of illness occur during or shortly after pesticide application. Be sure to take along the product label or container.
- Store pesticides out of the reach of children.
- Store pesticides where there is no chance of contact with human food or livestock feeds. Do not store herbicides with insecticides, and avoid cross-contamination. Storage areas should be locked.
- Keep chemicals in their original containers, never in unmarked containers or bottles used for food or drink.
- Never fill spray tanks directly from a drinkable water source such as a well or dugout.
- Follow proper container disposal methods. All containers should be triple rinsed or pressure rinsed, punctured to render the container nonreusable, and delivered to designated disposal sites.

Pesticide Container Disposal

Rinse all pesticide containers prior to disposal to reduce environmental contamination.

Triple Rinsing

Triple rinsing renders used pesticide containers (metal, plastic, glass) more than 99.9% free or residues in most cases.

Here are the steps that should be followed:

1. Empty contents of the container into the spray tank and drain in a vertical position for 30 seconds.
2. Add a measured amount of rinse water or other diluent so container is about 1/5 full.
3. Rinse the container thoroughly and pour into the spray tank.
4. Repeat the procedure three times; it should only take about 5 minutes in total.
5. Triple rinsed containers should be punctured or broken to render them non-reusable. Paper bags should be rinsed once prior to disposal.

Pressure Rinsing

Pressure rinsers are also available; they have the versatility to rinse all sizes of empty pesticide containers that can be lifted into position over the spray tank.

Pressure rinsers are all constructed to be thrust into the bottom of a metal can or plastic jug. Holes, situated laterally in the rinser tip, direct water from a pressurized source onto the inner sides of the container and effectively wash the residual pesticide into the spray tank.

Some farmers have found it convenient to attach a rinser to the pump on their large water storage tank to minimize container handling.

A 30 second rinse with any of these pressure rinsers is convenient and just as effective as triple rinsing.

Pressure rinsers have the added advantage of rendering containers useless by automatically puncturing them.

Disposal of Containers

Properly rinsed containers should be delivered to a designated pesticide container disposal site. Contact your Ag Rep or Weed Supervisor for the locations of pesticide container disposal sites in your municipality.

Pesticide Spills

If a pesticide spill appears to be major (a hazard to property or environment), call:

Environmental Management Branch
Building 2, 139 Tuxedo Ave.
Winnipeg, Manitoba R3N 0H6
Telephone: 945-4888 (24 hours)

Pesticide Drift

Pesticide drift can leave unwanted residues on adjacent crops, create a hazard to people and livestock nearby, and reduce the amount of material in the target area so that it is ineffective.

Those applying pesticides should make every effort to minimize or prevent pesticide spray drift by:

- correct calibration and maintenance of spray equipment;
- correct operation of the equipment;
- being aware of the toxicity of the pesticide being used;
- being aware of the weather conditions.

Custom Application — Ground and Air

Custom applicators must be licensed by Manitoba Agriculture. For further information, contact Andy Kolach — 945-3859 (Wpg).

It is an offense under the Federal Pest Control Products Act to use a control product under unsafe conditions. Precautionary practices must be heeded at all times to prevent drift. Extra precautions should be taken when using insecticides applied by air, especially those known to be toxic to honeybees — e.g. Sevin (carbaryl).

Do not spray in winds above 15 km/h (nine mph). Within ½ hour of sunrise or sunset, do not spray in winds above 10 km/h (six mph).

Tank Mixes

A tank mix is when two separately purchased pesticides are mixed in the sprayer tank, as opposed to one pre-formulated mixture sold by the manufacturer. For specific details on tank mixing, refer to label recommendations provided by the manufacturers of the pesticides.

Tank mixes can include the use of two similar pesticides (such as herbicides) or may include two different pesticides (such as an insecticide combined with a fungicide). There are several tank mixes of insecticides and fungicides used by vegetable growers.

Use only tank mixes when registered and recommended as mixes. Use of unregistered tank mixes can result in crop injury or reduced pest control. When tank mixing, observe all precautions and restrictions on both pesticide labels. Follow the longest time period for re-entry and harvest wait period.

CHEMICAL	TREATMENT	PRODUCT NAME
Benomyl, captan, lindane	Su, Du	Gammasan plus Flow. Rapeseed Treatment
	Du	Gammasan Seed Treatment Powder
Benomyl, thiram	Wp	Benlate T Benomyl - Thiram Fungicide Seed Dressing
Benomyl, thiram, lindane lindane	Du	Thiralin-plus
	Du	Ipco Benolin-R Insecticide /Fungicide Dust
Captan	Su	Chipman Flowable Seed Treatment
	Wp	Captan 75 Seed Protectant
	Su	Captan SP-4 Flowable
Captan, diazinon	Wp	Chipman Agrox I.F Dual Purpose Seed Treatment
Captan, lindane, diazinon	Du	Agrox D-L Plus Insecticide/Fungicide Drill and Seed Treatment Powder
	Du	Pickseed DLC Seed Box Treatment
	Du	Drillbox Diazinon-Lindane Plus Captan Seed Treatment Powder
	Du	Ciba-Geigy DCL Slurry Dual Purpose Seed Treatment
	Du	Pfizer - DCL Drill Box Seed Treatment
	Du	Co-op Rapeseed and Mustard Seed Treatment
	Du	Co-op D-L & C Drill Box Seed Treatment

	Wp	Chipman B-3 Dual Purpose Seed Treatment
Captan, thiophanate-methyl diazinon	Du	DCT Dual Purpose Seed Treatment
Carbathiin	Sn	Vitavax Solution Seed Protectant
	Sn	Vitavax Single Solution
Carbathiin, lindane	Sn	Vitavax Dual Solution
Carbathiin, thiram	Du	Vitavax Powder
	Su	Anchor
Carbathiin, thiram, lindane	Du	Vitavax RS Powder
	Su	Vitavax RS Flowable
	Du	Vitavax Dual Powder Seed Protectant
Carbofuran	Gr	Furadan CR-10
	Gr	Furadan 5G
Fenaminosulf	Wp	Lesan
Iprodione, lindane	Sn	Rovral ST
Lindane	Wp	Lindane
Maneb	Wp	Agrox NM Drill Box & Slurry Seed Treatment Powder
	Su	Agrox Flowable Seed Treatment Fungicide
	Du	Pool NUM Drill Box Seed Treatment

	Du	Pool Seed Treat Powder
	Wp	Manzate D Agro, Fungicide
	Du	Co-op NM Drill Box Seed Treatment
Maneb, lindane	Du	Pool NM Dual Purpose Drill Box Seed Treatment
	Su	Mergamma Flowable Dual Purpose Seed Treatment
	Du	Pool Dual Purpose Seed Treatment
	Du	Mergamma NM Drill Box Purpose Seed Treatment
	Du	Co-op NM Dual Purpose Seed Treatment
Mancozeb	Wp	Manzate 200 Mancozeb Fungicide
Metiram	Wp	Polyram 7 Dust
	Su	Polyram 7 Fungicide Seed Protectant
Terbufos	Gr	Counter 5G
Thiabendazole, thiram lindane	Sn	Premier
Thiram	Wp	Thiram 76 WP Wettable Powdery Fungicide
	Su	Thiram 320 Flowable Fungicide
	Wp	Thiram 75-WP
	Wp	Pfizer Thiram 75 Seed Fungicide DU Thiram 320 (Uniroyal)

DISEASE CONTROL IN CEREALS, SPECIAL CROPS AND POTATOES

Barley

Smuts - Treat seed of varieties listed as having fair resistance to loose or surface borne smuts (covered and false loose) with a suitable fungicide every three years. Varieties with poor resistance should be treated every two years. See Table 2.

Leaf spots - fungi which cause leaf spot diseases of barley overwinter on barley straw, stubble, and on seed. Treat seed from infected fields to reduce seedling infection. See Table 1 for more information. Treat seed from infected fields to reduce seedling infection. Planting barley after barley enhances the potential severity of net blotch and spot blotch, particularly in younger plants. See Table 2 for more information. For a list of recommended foliar fungicides see page 27.

Ergot - If ergot has been a problem, rotate with a non-susceptible crop for one year to reduce disease incidence (see Table 2). Cultivate fields after harvest to bury ergot bodies to a depth of at least 5 cm (2 inches) and mow grass headlands and roadsides before heading to reduce ergot spread. If the seed source is known to contain ergot bodies, storage for more than one year reduces their viability to almost zero. Levels of ergot bodies in the harvested grain above 0.1 per cent by weight may be toxic to livestock feed.

Oats

Early seeding and heavier seeding rates will reduce damage by barley yellow dwarf virus. Current varieties have good resistance to smut, leaf rust and stem rust.

Rye

Seed Rot and Seedling Blights -- Rye seed should be treated with a suitable treatment product to reduce seed rot, seedling blights and stem smut. See Table 1 for additional information.

Ergot -- for ergot problems, rotate with a non-susceptible crop for one year to reduce incidence (see Table 2). Cultivate fields following harvest to bury ergot bodies to a depth of at least 5 cm (2 inches) and mow grass headlands and roadsides before heading to reduce spread. If the seed source is known to contain ergot bodies, storage for more than one year will reduce their viability to almost zero. Levels of ergot bodies in the harvested grain above 0.1 per cent by weight may be toxic in livestock feed.

Triticale

Ergot -- Triticale is slightly more susceptible to ergot than wheat. If this is a problem, rotate with a non-susceptible crop for one year to reduce incidence (see Table 2). Cultivate fields following harvest to bury ergot bodies at least 5 cm (2 inches). Mow grass headlands and roadsides before heading to reduce spread. If the seed source contains ergot bodies, storage for more than one year reduces their viability to almost zero. Ergot body levels in the harvested grain above 0.1 per cent by weight may be toxic in livestock feed.

Wheat

Loose smut or Bunt -- Seed of varieties having fair resistance to loose smut or bunt should be treated with a suitable fungicide every three years. Those with poor resistance every two years. See Table 1.

Smut -- Semi-dwarf wheat varieties are all very susceptible to loose smut and bunt. All seed of semi-dwarf wheat should be treated with the systemic fungicide carbathiin, available as Vitavax and Vitaflo, annually for prevention of smut.

Ergot -- If ergot has been a problem, rotate with a non-susceptible crop for one year to reduce incidence (see Table 2). Cultivate fields following harvest to bury ergot bodies to a depth of at least 5 cm (2 inches) and mow grass headlands and roadsides before heading to reduce spread. A seed source known to contain ergot bodies should be stored for more than one year to reduce viability to almost zero. Levels of ergot bodies in harvested grain above 0.1 percent by weight may be toxic in livestock feed.

Fusarium head blight -- Fusarium head blight can develop in a wheat crop when infected debris is present. Preliminary observations suggest that durum and semi-dwarf wheats may be more susceptible to head blight. Experience in southern Ontario indicates that overwintered corn debris can result in the most damage to the subsequent crop. To minimize the risk of Fusarium head blight in outbreak areas, incorporation of debris and rotations away from wheat and corn may be beneficial.

Tan Spot/Septoria leaf and glume blotch -- Tan spot and Septoria diseases are becoming more prevalent in wheat in Manitoba. The causal organisms are fungi which survive from one year to the next in infected wheat straw and stubble. Rotations away from wheat for at least one year are recommended to reduce disease severity. Early-season outbreaks of tan spot/Septoria have been found in fields cropped to wheat the previous year. For a list of recommended foliar fungicides see page 27 and Table 4.

Powdery mildew -- Powdery mildew is not normally a problem in spring wheat but has been observed at higher levels in winter wheat and semi-dwarf wheat varieties. Mildew levels sufficient to cause

damage may occur in dense crops under moderate to high humidity. For a list of recommended foliar fungicides see page 27 and Table 4.

Stem and Leaf Rust -- The semi-dwarf wheat varieties currently being grown in Manitoba are all resistant to rust. Neepawa wheat is listed as having poor resistance to leaf rust and Katepwa has only fair resistance. For a list of recommended foliar fungicides see page 27 and Table 4. Leaf rust can cause yield loss to susceptible varieties of spring wheat under favorable conditions for disease outbreak.

Winter Wheat

Follow a crop rotation of at least one year between wheat crops. Avoid other cereal crops in the rotation, to control soil borne diseases.

Rust -- All currently registered varieties of winter wheat are susceptible to stem and leaf rust. In some years severe losses may occur due to rust infection. Losses as high as 40% have been recorded in Manitoba under severe disease conditions. For a list of recommended foliar fungicides see page 28 and Table 4.

Tan Spot/Septoria leaf and glume blotch -- Tan spot and Septoria diseases are becoming more prevalent in wheat in Manitoba. The causal organisms are fungi which survive from one year to the next in infected wheat straw and stubble Rotations away from wheat for at least one year and recommended to reduce disease severity. Early-season outbreaks of tn spot/Septoria have been found in fields cropped to wheat in previous years. For a list of recommended foliar fungicides see page 28 and Table 4.

Loose Smut or Bunt -- Seed of varieties having fair resistance to loose smut or bunt should be treated with a suitable fungicide every three years. Those with poor resistance every two years. See table 1.

Canola - Rapeseed

Use seed from disease free fields. Treat seed to control seed rot and seedling blights and to prevent the introduction and establishment of blackleg into blackleg free areas (see Table 1). Where blackleg is already established in an area seed treatments are ineffective in controlling the disease. In these areas stubble should be incorporated to expedite rapid decomposition of canola trash and to reduce the liberation of Ascospores into the air. Do not sow canola or rapeseed adjacent to canola or rapeseed stubble. To control blackleg and soil borne disease follow a crop rotation of at least 4 years and control volunteer plants, wild mustard and other cruciferous weeds between canola crops. Avoid fababeans, field beans field peas, forage legumes, lentils, mustard, safflower, soybeans and sunflowers in the rotation because of Sclerotinia stem rot (See Table 2). For a list of recommended foliar fungicides see page 27 and Table 4.

Fababeans

Fababeans are susceptible to a number of diseases which attack other broad leaved crops. Use of seed known to be free of Ascochyta is recommended to avoid losses from seed borne Ascochyta blight. Follow a crop rotation of at least four years between successive crops of fababeans to control Ascochyta and other soil borne diseases. Because of Sclerotinia disease field beans, field peas, lentils, mustard, canola, rapeseed, safflowers, soybeans and sunflowers should be avoided in the rotation. For further information on Sclerotinia Disease, see the introduction -- Disease Control and Table 2.

Field Beans

Bacterial blight -- Use pedigreed seed or seed known to be free from bacterial blight.

Bean Rust -- Heavy infection of rust reduces yield particularly of pinto beans. After harvest turn under all bean refuse as completely as possible.

Sclerotinia Disease (white mould) -- Avoid fababeans, field peas, lentils, mustard, canola, rapeseed, safflowers, soybeans and sunflowers in the rotation. Fungicides may be applied as a protectant treatment (see page 27 and Table 4). Avoid dense foliage favorable for disease development by restricting nitrogen. Follow a crop rotation of four years to control Sclerotinia and other soil-borne diseases.

Field Peas

Field peas are susceptible to a number of diseases which attack other broad leaved crops. Use of seed tested for disease is strongly recommended to avoid losses from seed borne Ascochyta. Follow a crop rotation of at least four years between successive crops of peas to control Ascochyta and other soil borne diseases. Plant peas as far as possible from pea fields of the previous year. Bury refuse and stubble after harvest and control volunteer seedlings soon after emergence. Because of Sclerotinia disease, avoid field beans, lentils, mustard, canola, rapeseed, soybeans, safflowers and sunflowers in the rotation. For further information see the introduction -- Disease Control and Table 2.

Flax

For seed rot and seedling blight control, flax should be treated (refer to Table 1). Follow a four year crop rotation and avoid legumes, potatoes and sugar beets because of Rhizoctonia disease (see Table 2).

The recommended varieties are resistant to rust. Planting non

recommended rust susceptible cultivars, increases the risk of yield losses. To reduce the threat of pasmo and rust, use clean seed, control volunteer flax and plant early. Do not plant on or near flax stubble.

Lentils

Follow a crop rotation of four years for control of soil borne disease. Avoid fababeans, field beans, field peas, mustard, canola, rapeseed, safflower, soybeans and sunflowers in the rotation because of Sclerotinia disease (white mold). For further information, refer to the introduction -- Disease Control and Table 2. To prevent Ascochyta blight, plant only clean, non-discolored, sound seed. If there is doubt that the seed is free from the pathogen, obtain an agar plate test through the Plant Health and Plant Products Division, Agriculture Canada or an accredited laboratory. Turn under crop refuse soon after harvest, control volunteer seedlings and avoid planting lentils close to the previous year's field.

Mustard

Treat seed to control seed rot and seedling blights.

Follow a crop rotation of at least four years to control soil borne diseases. Because of Sclerotinia disease (stem blight), fababeans, field beans, field peas, lentils, canola, rapeseed, safflower, soybeans and sunflowers should be avoided in the rotation. For further information, see the introduction -- Disease Control and Table 2.

Potatoes

Practice crop rotations to prevent buildup in the soil of organisms that cause scab, blackleg, Rhizoctonia and wilts Avoid sunflowers flax and rapeseed in the rotation. The plow down of a green cover crop of oats reduces rhizoctonia in the soil. Seed piece treatment reduces the risk of introducing diseases into a new field. For Verticillium wilt control treat seed pieces with thiophanate methyl (Easout). A crop rotation of four to five years is recommended. If a shorter rotation is being followed void sunflowers, sweet clover, tomatoes, peppers, eggplant and alfalfa which are susceptible to Verticillium wilt. Rotate with cereals.

Sanitation of all potato storage, handling and hauling equipment and disposal of all used bags is essential for bacterial ring rot control. Disinfect storage facilities and equipment with a quaternary ammonia product, 0.6L/169 L (one pint/35 gal) of water or household bleach 5% solution at 700 ml/5 L (20 oz/gal) water. Use high pressure washers or a steam cleaning unit to clean equipment before moving between fields, particularly for seed potatoes. Maintain a wet surface during disinfection for a minimum of 10 minutes.

Dispose of culls carefully to prevent growth of plants. This helps to avoid contamination of the upcoming crop with bacterial ring rot or late blight. Care should be taken to plant potatoes in soil sufficiently warm for growth (approximately 7 degrees celsius) in order to control blackleg, rhizoctonia and seed piece decay. A regular spray program will control early and late blight diseases.

To control the storage diseases silver scurf and fusarium dry rot, avoid bruising potatoes when harvesting. Treat potatoes while going into storage with thiabendazole (Mertect). Mix 8 L/170 L water (1.9 gallons/40 gallons), then spray 2 L solution per tonne (64 oz/ton) Do not treat potatoes being exported with thiabendazole (Mertect) at the Canadian rates.

The United States rate is about one seventh of the Canadian rate. Consult current recommendations of the country to which the potatoes are being exported.

Blight - Early blight and late blight can be controlled by fungicidal sprays (see foliar fungicide section, page 27 and Table 4).

Soybeans

Follow a crop rotation of four years to control soil borne diseases (see Table 2). Avoid fababeans, field peas, lentils, mustard, canola, rapeseed, safflowers and sunflowers in the rotation because of Sclerotinia disease. For control of seedling rot, seedling blights, and seed maggots, apply a seed treatment as recommended in Table 1. For further information see introduction -- Disease Control and Table 2.

Sugar Beets

Follow a crop rotation of at least four years to control soil borne diseases (Table 2). Avoid canola, rapeseed and mustard in the crop rotation because of sugar beet cyst nematodes. All seed is treated against damping off diseases prior to sale.

Safflower

The variety Saffire is moderately susceptible to Alternaria blight and resistant to Sclerotinia head rot. Other commercially available varieties may be more susceptible to Alternaria blight and Sclerotinia head rot.

Safflower should not follow safflower in rotation because they are very susceptible to Alternaria blight. Because of Sclerotinia disease, fababeans, field beans, field peas, lentils, mustard, canola, rapesseed, soybeans and sunflowers should be avoided in the rotation.

Corn

Stalk rot is considered the major disease of corn in Manitoba. It causes diseased plants to break over before harvest, resulting in severe losses. Organisms causing the disease are present in all soil. The disease usually occurs following periods of severe stress such as drought, or prolonged cool weather. For control measures, see the Manitoba Agriculture publication "Field Corn in Manitoba". Continuous cropping of corn can lead to a buildup of stalk rot and corn smut. Seed should be treated with a suitable fungicide to prevent introduction of head smut (see Table 1). Rotate with cereals, other than wheat, or special crops for several years before returning field to corn (see Table 2). The Crop Rotation Chart published by Manitoba Agriculture contains further information on crop rotations.

Forage Grasses

Leaf diseases are the most commonly encountered and conspicuous disease problem with the forage grasses. If the incidence of leaf disease becomes severe rotate the field to other crops for several years.

Ergot can be a serious problem on bromegrass and wheat grasses. Mowing the grass at heading time will prevent the formation of ergot bodies in the developing florets. this also stops spread of the disease to nearby fields of rye, triticale, wheat or barley. After breaking up a seed field where ergot has been a problem avoid rye, triticale, wheat or barley for one year.

Forage Legumes

Forage legumes are susceptible to a number of leaf spot diseases. They are also affected by root and crown rots which may be associated with winter injury.

Foliar diseases overwinter on infected stubble and may build up to become a serious problem. Take severely infested fields out of production. Cut before leaf drop to minimize leaf loss, reducing the amount of overwintering disease. Early spring burning prior to new growth may also reduce leaf and stem diseases. Rotate with cereals or corn for at least one year before replanting to a forage legume (see Table 2).

Alfalfa and sweet clover are susceptible to Verticillium wilt. To help prevent its introduction plant alfalfa seed treated with the fungicide thiram. Avoid potatoes and sunflowers, because of common susceptibility to Verticillium wilt, in the rotation.

TABLE 1: Seed Treatment Fungicides and Insecticides

ACTIVE INGREGIENT	INSECT: WIRE-WORMS: Wheat	Oats	Barley	Rye	Flax	SEED MAG-GOTS: Field Beans	Corn	Soybeans	FLEE BEE-TLES: Canola (Rapeseed)	Mustard	DISEASE: SEED AND SEEDLING ROTS/BLIGHTS: Canola (Rapeseed)	Mustard	Peas	Cereals	Flax	Rye	Corn	Field Beans	Soybeans	SMUTS CARRIED ON SEED: Corn-Head Smut	Rye-Stem Smut	Wheat-Bunt	Oats-Smut	Barley-Covered	Barley-FalseLoose	IN SEED: Wheat-Loose Smut	Barley-False Smut	BLACK LEG: Canola (Rapeseed)	Verticillium Wilt: Alfalfa
INSECTICIDES																													
carbofuran (Gr)									●	●																			
lindane (Wp)	●	●	●	●		●	●																						
terbufos (Gr)									●	●																			
FUNGICIDES																													
benomyl-thiram (Du)											●																	●	
captan (Du, Wp)													●				●	●	●										
carbathiin (Sn)															●	●					●		●	●	●	●	●		
carbathiin-thiram (Du) (Su)														●	●	●	●		●	●	●	●	●	●	●	●	●	●		
fenaminosulf (Wp)													●																
maneb (Du, Su)														●	●	●							●	●	●	●			
mancozeb (Wp)															●								●	●	●	●			
thiram (Su, Wp)											●	●	●				●	●	●										●

TABLE 1: Continued

ACTIVE INGREDIENT	INSECT: Wireworms: Wheat	Oats	Barley	Rye	Flax	Seed Maggots: Field Beans	Corn	Soybeans	Flea Beetles: Canola (Rapeseed)	Mustard	DISEASE: SEED AND SEEDLING ROTS/BLIGHTS: Canola (Rapeseed)	Mustard	Peas	Cereals	Flax	Rye	Corn	Field Beans	Soybeans	Smuts Carried: On Seed: Corn-Head Smut	Rye-Stem Smut	Wheat-Bunt	Oats-Smut	Barley-Covered	Barley-False	In Seed: Wheat-loose smut	Barley-loose smut	Black Leg: Canola (Rapeseed)	Verticill Wilt: Alfalfa
DUAL PURPOSE																														
benomyl-captan-lindane (Du, Su)									●	●	●	●																		
iprodione-lindane (Su)									●																				●	
benomyl-thiram-lindane (Du)									●		●																		●	
captan, diazinon (Wp)						●	●	●					●				●	●	●										●	
captan, thiophanate-methyl, diazinon (Du)																		●												
captan----- lindane-diazinon (Du)						●	●	●					●				●	●	●											
carbathiin-lindane (Su)	●	●	●											●									●	●	●	●	●	●		
carbathiin-thiram-lindane (Du)	●	●	●	●	●								●	●	●	●					●		●	●	●	●	●	●		
(Su)	●		●						●	●	●	●		●									●		●	●	●	●	●	
maneb-lindane (Du)	●	●	●	●										●										●	●	●	●			
thiabendazole, thiram-lindane (Su)									●		●																			

Du- Dust
Wp- Wettable Powder
Su- Suspension
Sn- Solution
Gr- Granules

FOOT NOTES TABLE 1

GR = Granules

DU = Dust

SN = Solution

SU = Suspension

WP = Wettable powder

TABLE 2: CROP - DISEASE RELATIONSHIPS

For Crop Rotation Consideration

DISEASES	ALFALFA	BARLEY	BUCKWHEAT	CORN	FABABEANS	FIELD BEANS	FIELD PEAS	FLAX	LENTILS	MUSTARD	OATS	POTATOES	RAPESEED	RYE	TRITICALE	SAFFLOWER	SOYBEANS	SUGARBEETS	SUNFLOWERS	SWEETCLOVER	WHEAT	LONGEVITY *
Ascochyta Blight					A		B		C													4
Alternaria-Grey Leaf Spot										X			X									1
Bacterial Blight						A	B										C					1
Cyst Nematode										X			X					X				3
Ergot		X												X	X						Y	1
Fusarium Wilt & Root Rot	X				X	X	X	X	X	X			X				X		X	X		S
Fusarium Head Blight (Scab)		X		X																	X	1
Cochliobolus - Fusarium Common Root Rot		X																			X	2
Rhizoctonia Root Rot	X		X		X	X	X	X	X	X		X	X				X	X	X	X			S
Sclerotinia	X				X	X	X		X	X		X	X			X	X		X	X		4
Septoria (Cereals)		A									B										C	1
Verticillium Wilt	X											X							X	X		4
White Rust - Staghead										A			B									3

Diseases with different letters have same name on various crops but are caused by different species or boitypes of the pathogen. This implies that there is little risk of this diseases spreading between the indicated crops.

* = longevity of pathogen in soil or on trash in years.

S = pathogen is a soil organism and can survive indefinitely

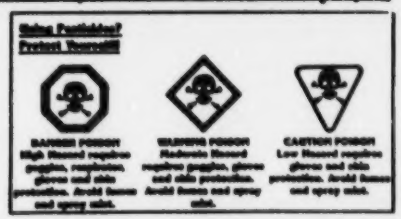
X = diseases can occur on crop

TABLE 3. Fungicides Recommended for Disease Control in Vegetable Crops

FUNGICIDE	Asparagus	Beans (snap)	Beets Red	Cabbage, Cauliflower, Brocc., Chinese	Carrots	Celery	Corn (Sweet)	Cucumbers, Pumpkins, Squash	Eggplants	Lettuce	Onions	Peppers	Potatoes	Radish	Rutabagas	Tomatoes	Angular Leaf Spot (Cucumbers)	Asparagus Crown Rot, Seedling Blight	Anthracnose (Beans)	Bacterial Blight (Beans)	Blast, Purple Blotch (Onions)	Downy Mildew (Broccoli, Cauliflower)	Downy Mildew (Onions)	Dry Rot (Potatoes)	Early and Late Blight and Leaf Spot (Carrot, Celery, Parsley, Potato, Tomato)	Gray Mold (Onions)	Head Rot (Corn)	Powdery Mildew (Cucumbers	Rust (Asparagus)	Scab (Cucumbers)	Seed Decay & Damp Off	Seed Piece Diseases (Potato)	Silver Scurf (Potato)	Smut (Onions)	White Mold (Beans and Carrots)
Benlate	X	14			7b			X									•											•		•					•
Bravo 500				7	1	7		1					1			1					•			•				•		•					
Captan (seed treatment)		X	X	X			X	X	X		X	X	X	X	X	X															X	X		X	
Benon, Lasan (seed treatment)		X	X				X	Xc																							X				
Dithane M-45, Manzate 200				7	7	7					10		1			1					•g		•g	•											
Dithane M-22, Manzate D					5				5		10		1			3					•g		•g	•							X				
Dyrene 50W						7					7										•g		•g	•											
Kasout												Xe																			X				
Fixed Copper 50W		1						1					1			1	•		•	•				•											
Kocide 101		1						1					1			1	•		•	•				•											
Mertect												Xd										•									X	X			
Polyram 80W	Xa				5	7							1			1								•				•			X				
Pro-Gro (seed treatment)											X																						•		
Rovral											15										•g				•										
Thiram (seed treatment)		X	X	X	X	X	X	X	X	X	X	X		X	X	X															X		•		
Vitavax 280 (seed treatment)							X																			•					X				

Legend

X — Recommended on crop
— Indicates disease controlled.
1-15 Numbers indicate recommendation for crops and days between last spray and harvest
a — Do not apply to asparagus spears prior to cutting; apply to plant after cutting
b — Post harvest dip or spray
c — Cucumbers only
d — Post harvest tuber and potato seed piece treatment
e — Potato seed piece treatment
f — Dry bulb only
g — Blast only


Using Pesticides?
Protect Yourself!
DANGER POISON
High Hazard requires goggles, respirator, gloves and skin protection. Avoid fumes and spray mist.
WARNING POISON
Moderate Hazard requires goggles, gloves and skin protection. Avoid fumes and spray mist.
CAUTION POISON
Low Hazard requires gloves and skin protection. Avoid fumes and spray mist.

NOTE: -- Refer to specific crop sections for diseases controlled and to determine recommended product formulation and rates.
-- Apply all fungicides according to label directions.

FOLIAR FUNGICIDE APPLICATIONS FOR FIELD CROPS AND POTATOES

SCLEROTINIA (stem rot) - Canola (rapeseed)

If necessary, Sclerotinia stem rot may be controlled by an application of benomyl (Benlate R) .4 -.6 kg/acre in 32-40 l/acre water ground application, 16 l/acre water aerial application or Iprodione (Rovral R Flo) .8 - 1.2 l/acre in 40 l/water ground, 18 l/acre aerial application. The higher rates of fungicide are recommended for fields with a history of heavy disease pressure or for dense crop stands.

WHITE MOLD (Sclerotinia) - Field Beans

Apply .7 -.9 kg/acre Benlate between 50% and full bloom with enough water to obtain thorough coverage. Under severe disease conditions the higher rate is recommended. Do not apply within 14 days of harvest. Do not graze or feed treated bean hay to livestock.

Apply .4 -.6 kg/acre Rovral 50WP when 25-75% of the blooms have opened, in 18 l/acre water for aerial application and 40 l/acre water for ground application.

EARLY BLIGHT - Potatoes

Use of one or more of several fungicides according to directions on the label is recommended Frequently, these disease control measures are combined with applications of insecticides where the mixture is compatible. Apply one of the following fungicides: maneb (Dithane M-22, Manzate D) at .88 kg/acre), mancozeb (Dithane M45, Manzate 200) at .88kg/acre), metiram (Polyram 80%) at .88 kg/acre), Bravo 500 at .64-.96 l/acre) or fixed copper 49-55 percent at .44-1.32 kg/acre).

LEAF RUST, TAN SPOT, SEPTORIA -- Hard Red Spring Wheat

Dithane M45 (Mancozeb). Apply 2 applications .9 g/acre each application. First application at growth stage 47 (Zadoks scale), when flag leaf has totally expanded. Second application 10 days later. Water volume 16 L/acre aerial, 40 - 80 L/acre ground, spray pressure 345 kpa (50 psi). Preharvest interval - 40 days.

LEAF RUST, STEM RUST, POWDERY MILDEW, TAN SPOT, SEPTORIA - Semi-dwarf and soft white spring wheat.

Dithane M45 (Mancozeb), same as above. Tilt (propiconazole) - One of 2 application dates. Stage 1 GS 30-37, just prior to emergence of flag leaf to when flag leaf is just visible. Early protection against powdery mildew and Septoria. Stage 2 GS49-55. just prior to ear emergence to when ear is hal emerged. Normal application time in Manitoba for rust, Septoria and tan spot control: 500 ml Tilt 250E/ha,

water volume 40-80 l/acre, ground application only. Spray pressure 200-500 kpa (30-45 psi). preharvest interval - 45 days

LEAF RUST, STEM RUST AND POWDERY MILDEW -- Winter Wheat

Dithane M45 (Mancozeb) - same as for hard red spring wheat Tilt (propiconazole) - same as for semi-dwarf and soft white spring wheat Bayleton (triadimefon) - application at 37-39 (Zadoks scale), at emergence of flag leaf. 100-200 g/acre, water volume 40-120 l/acre, ground application only. Preharvest interval - 60 days.

NET BLOTCH, SPOT BLOTCH, SCALD, POWDERY MILDEW, SEPTORIA, LEAF RUST - barley

Tilt (propiconazole) - application date between GS29-32 and GS45-5, depending on leaf disease development. Normally Gs 45-50 is recommended in Manitoba. 200 ml Tilt/acre. Water volume 40-80 l/acre ground application only. Spray pressure 200-300 kpa (30-45 psi). Preharvest interval - 45 days.

TABLE 4. Foliar Applied Fungicides
Wheat, Barley, Cereal, Field Beans and Potatoes

	active ingredient	anilazine	benomyl	captafol	chlorothalonil	fixed copper	iprodione	mancozeb	maneb	metiram	propiconazole	triadimefon
LEAF RUST	Hard Red Spring Wheat							●				
	Semi Dwarf							●			●	
	Winter Wheat							●			●	●
	Barley										●	
STEM RUST	Hard Red Spring Wheat											
	Semi Dwarf										●	
	Winter Wheat										●	●
SEPTORIA	Hard Red Spring Wheat							●				
	Semi Dwarf							●			●	
	Winter Wheat							●			●	
	Barley										●	
TAN SPOT	Hard Red Spring Wheat							●				
	Semi Dwarf							●			●	
	Winter Wheat							●			●	
POWDERY MILDEW	Hard Red Spring Wheat											
	Semi Dwarf										●	
	Winter Wheat										●	●
	Barley										●	
NET BLOTCH SPOT BLOTCH, SCALD	Barley										●	
SCLEROTINIA	Canola		●				●					
	Field Bean		●		●		●					
BACTERIAL BLIGHT	Field Bean					●						
EARLY and LATE BLIGHT	Potatoes	●		●	●	●		●	●	●		

MAJOR FUNGICIDES USED ON CEREALS, POTATOES, SPECIAL CROPS AND VEGETABLES

ANILAZINE

A broad spectrum protective foliar fungicide recommended for control of foliar diseases of vegetables.

Trade name: Dyrene

Registrants: Chemagro Ltd.

BENOMYL

Benomyl is a systemic fungicide for use on snap beans, field beans and canola for control of white mold.

Trade names: Benlate 50WP
Benolin R (seed treatment)
Gammasan+ - seed treatment for canola
Thiralin+ - seed treatment for canola

Registrants: Chipman Chemicals Ltd.
Dupont of Canada Ltd.
May & Baker Canada Ltd. (seed treatment)
Inter-Provincial Co-op (seed treatment)

CAPTAN

Captan is a fungicide used primarily as a seed treatment on special crops and vegetables.

Trade names: Captan
Orthocide

Registrants: Ciba-Geigy Canada ltd.
Chipman Chemicals Ltd.
Chevron Chemical (Canada) Ltd.
Pfizer Co. Ltd.
Stauffer Chemical Corp. of Canada
Uniroyal Ltd.

CARBATHIIN

Carbathiin is a systemic fungicide effective against various seed borne smuts, blackleg of rapeseed and seedling blights of cereals and special crops. It is applied to the seed at planting time. Various formulations are registered for use on wheat, oats, alfalfa, onions, barley, rye, flax, rapeseed, mustard.

Trade names: Vitavax, Vitavax RS - seed treatment for cereals, flax, canola, mustard

Anchor - seed treatment for wheat, barley, oats, flax, rye, triticale and soybeans.
Pro-Gro - seed treatment for onion smut

Registrant: Uniroyal Ltd.

CHLOROTHALONIL

A broad spectrum protectant fungicide to control foliar diseases of vegetables and potatoes.

Trade names: Bravo

Registrants: SDS Biotech

COPPER (FIXED)]

Broad spectrum fungicide and bactericide. Used for controlling foliar diseases caused by fungi and bacteria on sugar beets, beans, potatoes and some vegetables. Copper compounds are also used as algicides and wood preservatives. There are several different forms of fixed copper fungicides.

Trade names: Fixed copper 50W
Kocide 101

Registrants: Pfizers Co. Ltd.
Niagara Chemical
Kocide Chemicals Co. Chemical Corp.

FENAMINOSULF

A very persistent fungicide for use on seed of beans, beets, corn and peas. It controls seed decay. A mixture of fenaminosulf and quintozene is registered as a seed treatment for damping off of sugar beets.

Trade names: Lesan (formerly Dexon)

Registrants: Chemagro Ltd.

IPRODIONE

A broad spectrum contact fungicide. Registered for control of sclerotinia disease affecting canola, field beans and snap beans and as a seed treatment for canola to control blackleg. It is also registered for control of Botrytis fruit rot of strawberries.

Trade names: Rovral 50WP, Su
Rovral ST, Su

Registrants: May & Baker Canada Ltd.

MANCOZEB

Mancozeb is a contact fungicide with protective action for use in controlling fungus leaf diseases of vegetables and potatoes. It is also registered for control of covered smut and false loose smut of barley, smut of oats, bunt of wheat, seedling blight and seed rot of flax. Mancozeb has a similar activity to maneb. Dithane M45 is registered for control of leaf rust, tan spot and Septoria on all types of wheat.

Trade names: Manzate 200
Dithane M45

Registrants: Dupont of Canada Ltd.
Ciba-Geigy Canada Ltd.
Rohm & Haas Co. Of Canada Ltd.
Chipman Chemicals Ltd.

MANEB

Maneb is a general purpose broad spectrum fungicide used to control potato and vegetable foliar diseases. It has a protectant and an eradicant action. It is registered as a seed treatment for control of covered and false loose smut of barley, bunt of wheat and smuts and seedling blight of oats by several companies. (see seed treatment table).

Trade names: Maneb
Manzate D
Dithane M22
Agrox (see seed treatment table)
Mergamma (see seed treatment table)

Registrants: Chipman Chemicals ltd. (st)
May & Baker Canada Ltd.
Alberta Wheat Pool (st)
Dupont of Canada Ltd.
Interprovincial Co-ops Ltd. (st)
Pfizers Co. Ltd.
Rohm & Haas Co. of Canada Ltd.
Saskatchewan Wheat Pool (st)
(st) = seed treatment

METIRAM

A protectant action fungicide for foliar diseases of potatoes and vegetables. It is also used as a potato seed piece treatment.

Trade names: Polyram

Registrants: BASF Canada Inc.

PROPICONAZOLE

A fungicide with both protectant and eradicant action. Registered for control of leaf and stem rust, tan spot, Septoria and powdery mildew of winter wheat, Prairie spring (semi-dwarf) and soft white wheat varieties.

Trade names: Tilt

Registrants: Ciba-Geigy Canada Ltd.

THIABENDAZOLE

A broad spectrum preventative curative fungicide with activity similar to benomyl and thiophanate methyl. Registered for use on potatoes as a post harvest (pre storage) application for control of storage diseases. Also registered for control of leaf spot of sugar beets, and a seed treatment for blackleg of canola.

Trade names: MerLect
Premier

Registrants: Chipman Chemical ltd.
Ciba-Geigy Canada Ltd.

THIOPHANATE-METHYL

Thiophanate-methyl is a broad spectrum preventative curative systemic fungicide closely related to benomyl and thiabendazole. It is used as a seed piece treatment for potatoes.

Trade names: Easout

Registrants: Ciba-Geigy Canada Ltd.

THIRAM

A broad spectrum protective action fungicide. Thiram is mainly used as a seed treatment for cereals, special crops and vegetables, and verticillium wilt of alfalfa.

Trade names: Anchor
Thiram
Basinet & Thiram 5%-10% Granular- for onion smut control
Ethion 5 Thiram 7.5-G Granular - for onion smut control
Pro-Gro - for onion smut control

Registrants: Uniroyal Ltd.

Pfizer Co. Ltd.
Stauffer Chemical Co. of Canada Ltd.
Dupont of Canada Ltd. (seed treatment)
Chemagro Ltd.
Niagara Chemicals (seed treatment)
May & Baker Canada Ltd.

TRIADIMEFON

A fungicide with both protectant and eradicant activity. Effective against leaf and stem rust and powdery mildew of wheat. Registered for use only on winter wheat.

Trade name: Bayleton

Registrants: Chemagro Ltd.

FUNGICIDE INDEX

CHEMICAL	TRADE NAMES
Anilazine	Dyrene
Benomyl	Benlate, Benolin R, Gammasan+, Thiralin+
Captan	Captan, Orthocide
Carbathiin	Anchor, Vitavax, Pro-Gro
Chlorothalonil	Bravo
Copper (fixed)	Kocide 101, Fixed Copper 50W
Fenaminosulf	Lesan, Dexon
Iprodione	Rovral
Mancozeb	Manzate 200, Dithane M45
Maneb	Agrox, Maneb, Manzate D, Mergamma, Dithane M22
Metiram	Polyram
Propiconazole	Tilt
Thiabendazole	Mertect, Premier
Thiophanate-methyl	Easout
Thiram	Pro-Gro, Thiram, Anchor
Triadimefon	Bayleton